Maintenance Guide

ENGINES
ELECTRIC SETS
MARINE ENGINES

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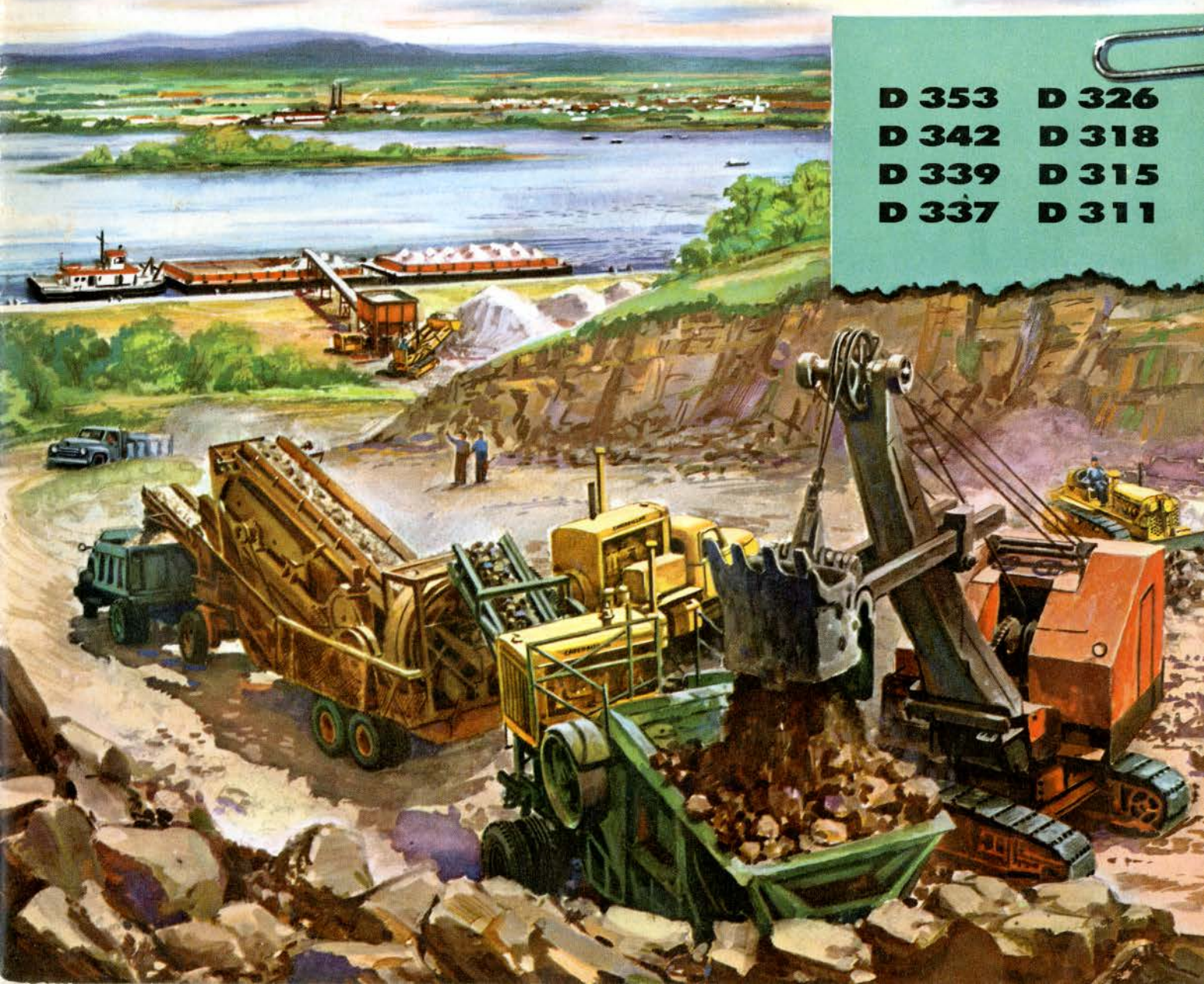


Maintenance Guide

ENGINES
ELECTRIC SETS
MARINE ENGINES

Experienced equipment operators know the importance of good machinery maintenance—that correct maintenance pays off through more reliable service, greater operating economy and longer machine life. Sometimes through the pressure of work schedules or the inexperience of new operators, proper equipment servicing is neglected.

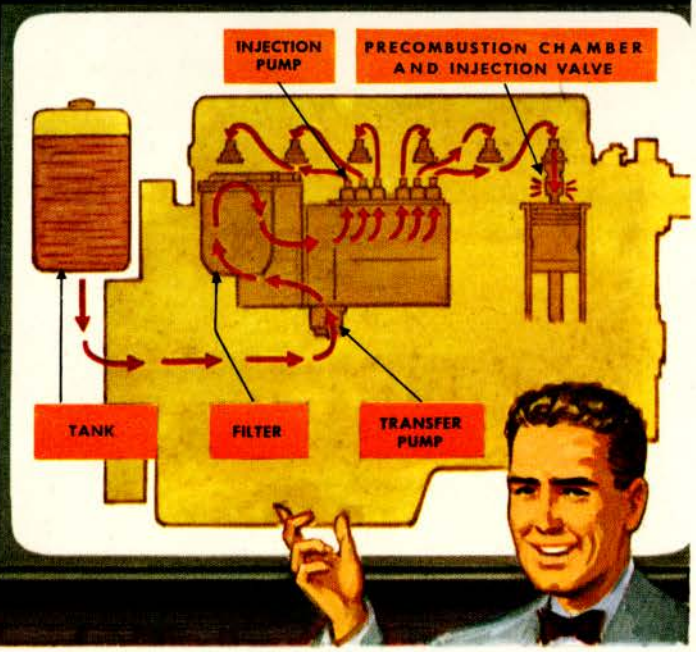
Here is a maintenance booklet prepared especially for you. It presents information on the correct servicing of Caterpillar Diesel Engines, Electric Sets and Marine Engines. More detailed instructions are given in the Operation and Maintenance Instructions book for your particular Cat Engines. And your Caterpillar Dealer will be happy to arrange service training meetings for you and your operators at your convenience.

1
HAL, I'VE GOT A NEW GROUP OF OPERATORS ON THIS CRUSHER, AND I THINK WE SHOULD TELL THEM THE PROPER WAY TO SERVICE THESE ENGINES. COULD YOU GIVE THEM THAT SAME PITCH YOU GAVE OUR BUNCH OVER AT PLACID VIEW LAST SUMMER?
2
SURE, JACK. I'LL BE HAPPY TO GIVE YOU A HAND. WHERE DO YOU WANT TO MEET? -YOUR SERVICE SHOP-9 O'CLOCK SATURDAY MORNING-O.K., JACK. SEE YOU THEN.
CATERPILLAR
CAT D9
H. L. SMITH
3
FELLOWS, JACK INVITED ME TO COME OUT THIS MORNING TO GIVE YOU A FEW TIPS ON PROPER SERVICING OF YOUR CAT ENGINES.

SUPPOSE WE GET RIGHT DOWN TO BUSINESS AND SEE WHAT IT TAKES TO KEEP YOUR EQUIPMENT OPERATING DEPENDABLY, ECONOMICALLY AND FOR A LONG TIME.

ANTI-FREEZE

THE HEART OF YOUR DIESEL ENGINE IS ITS FUEL SYSTEM. MOST FUEL SYSTEM TROUBLES ORIGINATE WITH FUEL STORAGE.



Keep fuel clean. The best fuels can become unsatisfactory through careless handling or poor storage. It is practically impossible to keep cans, funnels and drums clean.

7

Store fuel away from dusty areas in a good storage tank having a drain petcock and a pump for transferring fuel.

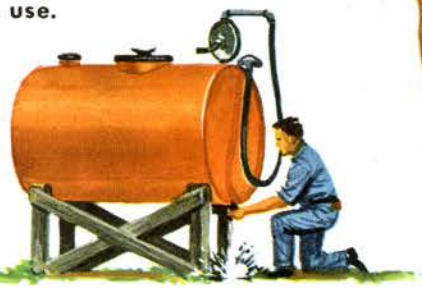
8

Fill storage tank from fuel truck through hose. To settle out contaminants let fuel stand 24 hours before use.

9

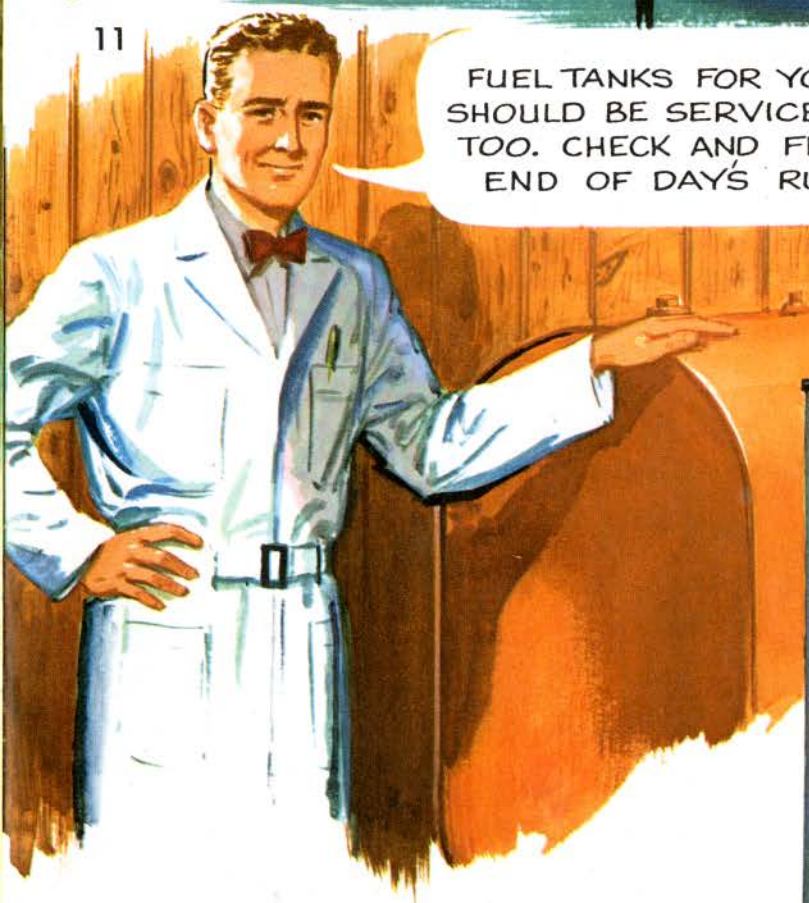
Use transfer pump to draw off fuel for engine tanks. In the field, fill tanks directly from tank truck.

10



Before refilling storage tank drain off sediment and water. Occasionally clean the tank.

11



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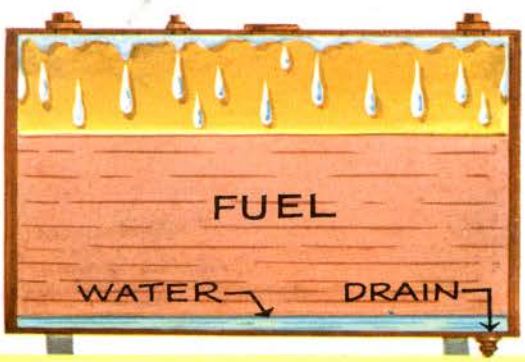
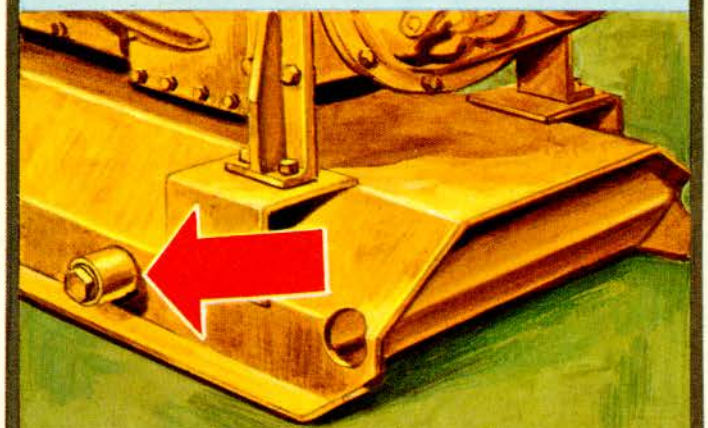


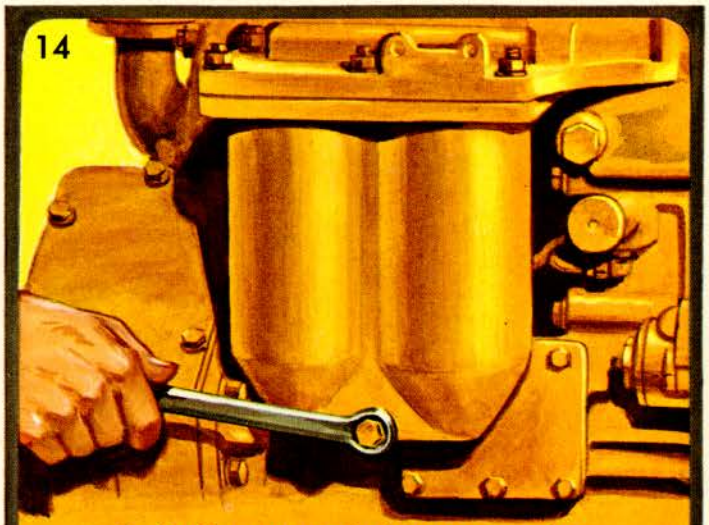
Partially filled tanks sweat—moisture collects on the inside and drops into the fuel. Every 125 hours, before starting the diesel, drain off sediment and water.

13 If water should get into your engine —*HERE'S WHAT TO DO:*



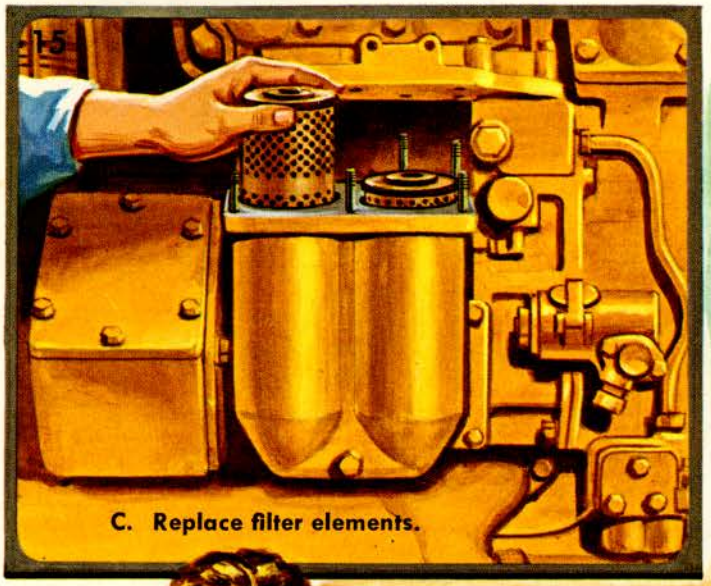
A. Drain water from tank.

14



B. Drain water and sediment from bottom of fuel filter housing.

15



C. Replace filter elements.

16

WATER IN FILTER HOUSING CAUSES FILTER ELEMENTS TO BECOME SOGGY AND SWOLLEN THUS RESTRICTING FLOW OF FUEL.

17

WHEN THE FUEL SUPPLY IS BROKEN OR AIR IS IN THE LINES, THE FUEL SYSTEM MUST BE PRIMED. SEE YOUR OPERATION AND MAINTENANCE INSTRUCTIONS FOR CORRECT PROCEDURE.

18

FUEL SYS TIPS

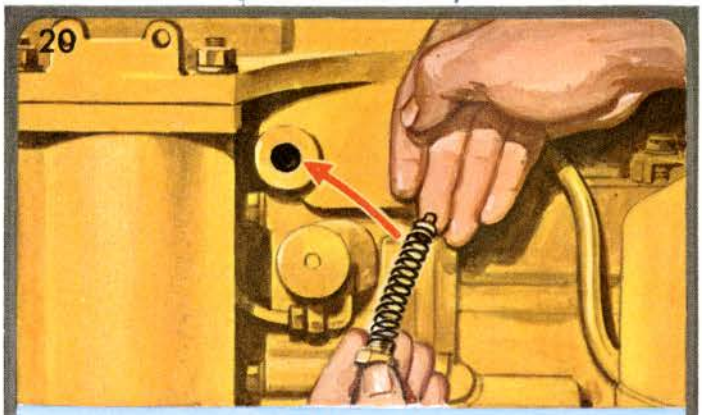
HERE ARE SOME POINTS TO WATCH IN THE FUEL SYSTEM:

19

FILTER ELEMENTS

Check fuel pressure gauge. Gradually lowering pressure means dirty filters. Replace elements when necessary.

20



BY-PASS VALVE

A sudden reduction of fuel pressure means there is dirt on the by-pass valve seat. Remove and clean by-pass assembly.

21

FUEL PUMPS

If exhaust is clear but engine lacks power and is hard to start, have your dealer serviceman check the pumps on his test apparatus.

22

FUEL VALVES

When exhaust shows intermittent puffs of smoke and engine runs irregularly—check injection valves. If an injection valve sticks, solid fuel is injected continuously and engine knocks severely.

23

CHECK FOR STICKING VALVE

By momentarily loosening nut securing each line to its pump, the sticking valve can be located where loosened nut makes no difference in engine operation.

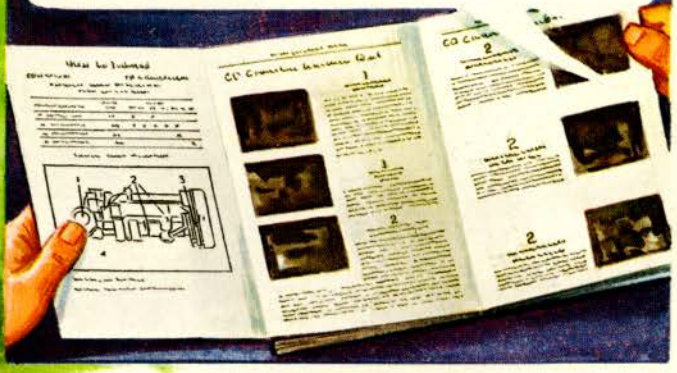
It's a good idea to read this booklet. Consult it again when you experience any difficulty. If the trouble persists, call your Cat Dealer.

24

LET'S TAKE A LOOK AT *LUBRICATION* PROPER SELECTION OF LUBRICANTS WILL ADD MUCH TO ENGINE PERFORMANCE, ECONOMY AND LONG LIFE.

25

YOUR OPERATION AND MAINTENANCE INSTRUCTIONS SPECIFY THE LUBRICANT AND WEIGHT OF LUBRICANT TO BE USED. IT SHOWS THE POINTS TO BE SERVICED AND THE HOURLY SERVICE INTERVALS.



26

AN ADDITIVE TYPE LUBRICATING OIL SHOULD ALWAYS BE USED IN YOUR ENGINE. RECOMMENDED LUBE OIL IS SUPERIOR LUBRICANT SERIES 3.

27

Check service meter reading to determine lubrication time for all parts. When the engine crankshaft turns as many revolutions as are made in an hour at normal operating speed, the dial advances one number. The meter does not record "clock" hours.

28

OUR OIL BECOMES DARK *PRETTY FAST.* SHOULDN'T WE CHANGE IT THEN ?

29

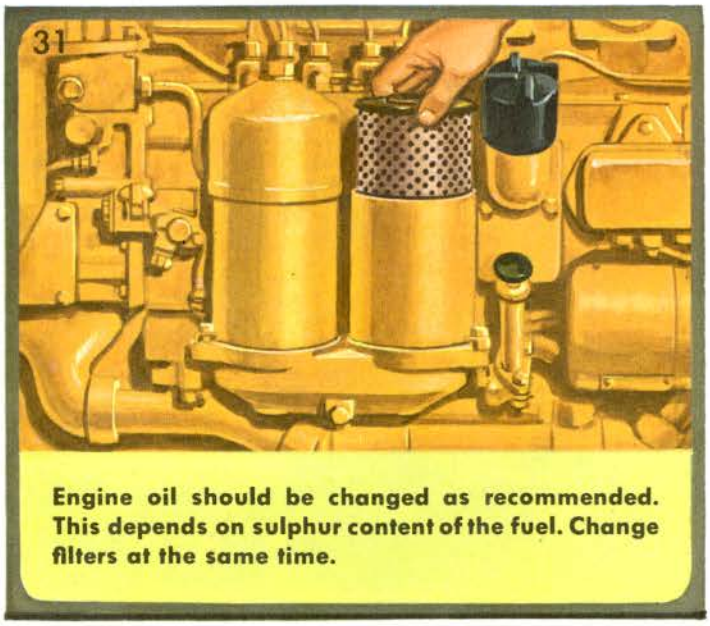
NO, BECAUSE ADDITIVE OILS HOLD CARBON IN SUSPENSION SO THE OIL LOOKS DARK. STRAIGHT MINERAL OILS ARE UNABLE TO DO THAT. JUST REMEMBER THIS – DON'T USE STRAIGHT MINERAL OILS IN YOUR ENGINE. THEY FAIL TO KEEP WORKING PARTS FREE OF CARBON, LACQUER AND GUMS. ADDITIVES ARE USED TO IMPROVE THE PROPERTIES OF STRAIGHT MINERAL OILS.

HERE ARE SOME ADDITIONAL POINTS TO REMEMBER.

DETERGENT ADDITIVES KEEP ENGINE PARTS CLEAN BY HOLDING UNDESIRABLE PRODUCTS IN SUSPENSION IN THE OIL.

ANTI-OXIDANT ADDITIVES RESIST CHEMICAL CHANGES IN THE OIL—CHANGES CAUSED BY HEAT AND OXYGEN.

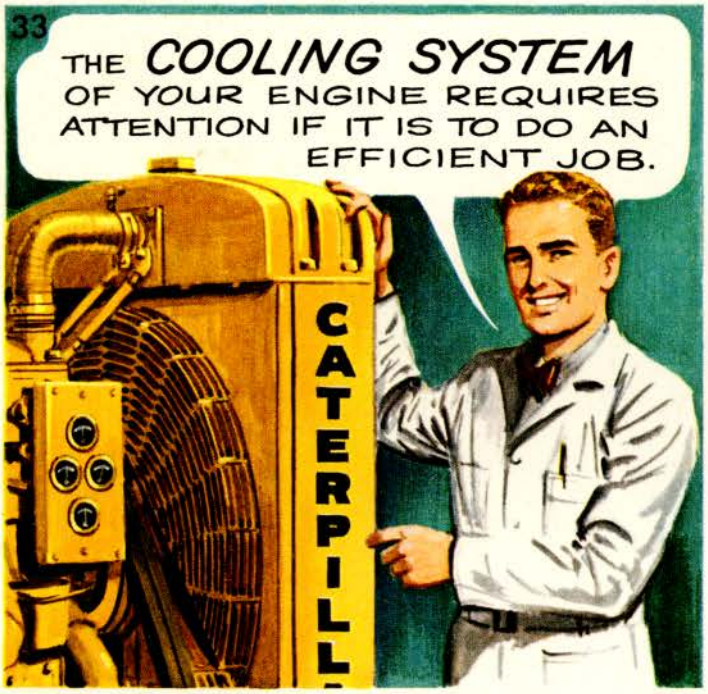
CORROSION INHIBITORS PROTECT ENGINE PARTS FROM CORROSIVE ACIDS.

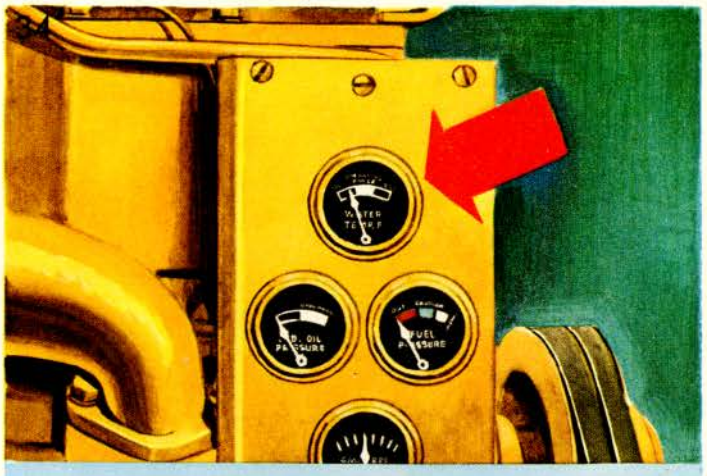


Engine oil should be changed as recommended. This depends on sulphur content of the fuel. Change filters at the same time.

Clean filter housing and replace elements. Use original Cat filter elements which remove abrasive particles up to fifty times smaller than a human hair.

33



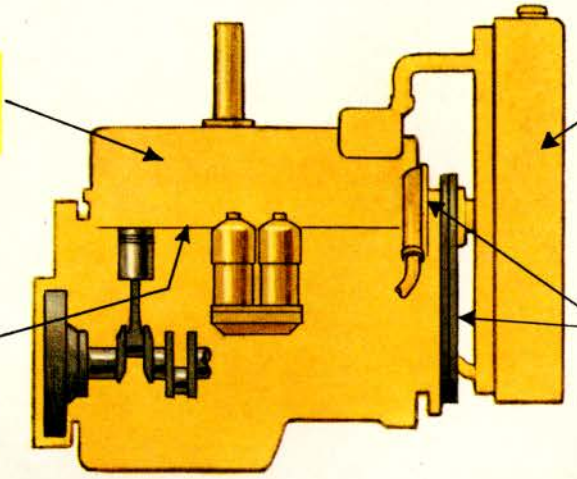


At normal operating temperature the needle of the water temperature indicator should remain within the **NORMAL OPERATING** (or white) area of the dial. If coolant in the engine boils, the trouble usually can be traced to one of several causes.

35

Insufficient water in the cooling system.

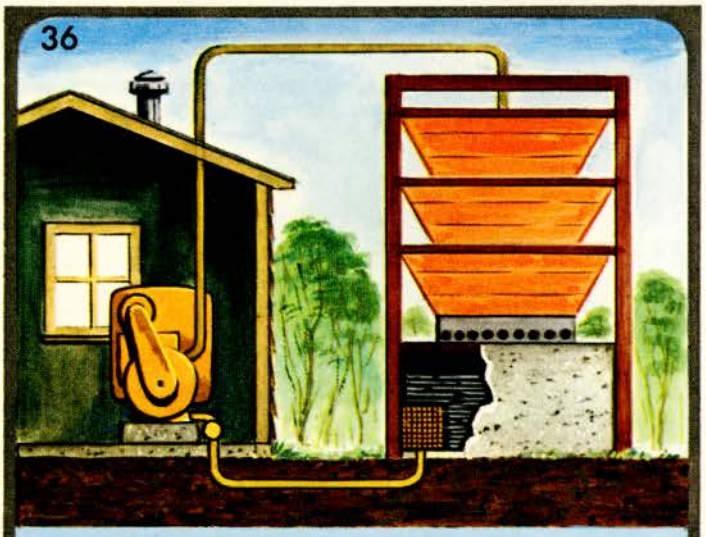
Internal trouble with the engine such as a leaking head gasket or precombustion chamber seal will cause combustion gases to displace the water.



Obstructions in the radiator—damaged core—bent fins on the radiator.

Other causes of overheating are loose or broken fan belt, loose pump impeller, broken pump shaft or frozen radiator.

36

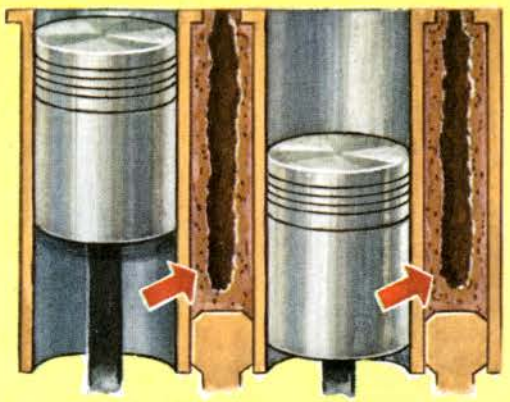


When a cooling tower is used, keep coils free from scale, and raw water strainer cleared of leaves and sediment.

37

If radiators are used inside buildings, use a blower fan and make sure there's plenty of cooling air for engine.

38



Use any clean soft or chemically softened water in your cooling system to prevent formation of rust or scale. When mineral deposits coat the metal walls of your engine, heat cannot get through to be carried off by the water.

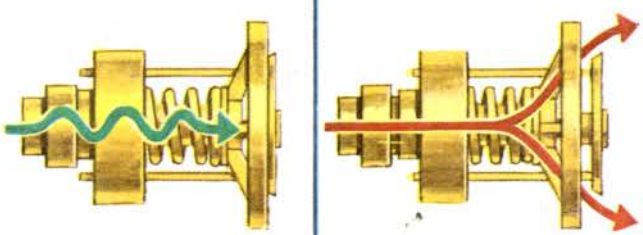
39

AS AN ADDED PREVENTION, USE CATERPILLAR RUST INHIBITOR IN YOUR ENGINE COOLING SYSTEM.

40

THE WATER TEMPERATURE REGULATOR, HERE, KEEPS YOUR ENGINE OPERATING AT CORRECT TEMPERATURE – NEITHER TOO HOT NOR TOO COOL.

41



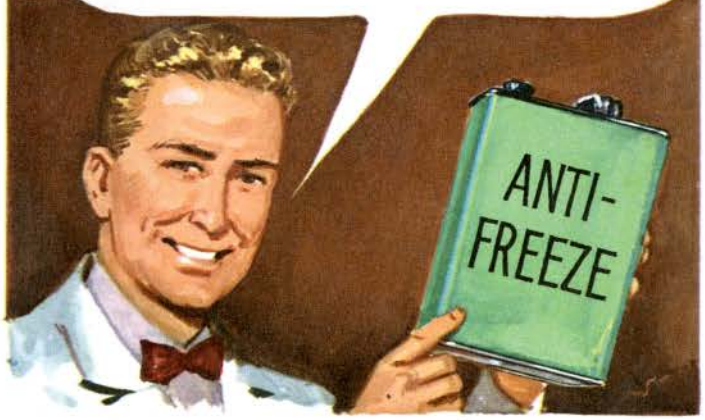
The regulator should restrict flow of water to the radiator when the engine is cool. It should let water pass when it's hot.

42

FOR PROPER COOLING KEEP RADIATOR CORES CLEAN – WASH, BLOW OR BRUSH DEPOSITS FROM BETWEEN RADIATOR TUBES.

43

PERMANENT-TYPE ANTI-FREEZE IS RECOMMENDED WHEN TEMPERATURES ARE BELOW FREEZING. IF ALCOHOL IS USED, TEST COOLANT FREQUENTLY TO ASSURE CORRECT STRENGTH.



44

THE **AIR SYSTEM** IS ONE OF THE MOST VITAL PARTS OF YOUR ENGINE. THE AIR CLEANER BREATHES IN THOUSANDS OF CUBIC FEET OF AIR EVERY HOUR OF OPERATION. A PROPERLY SERVICED AIR CLEANER REMOVES ABRASIVE MATERIALS FROM THE AIR—THUS ASSURING LONG LIFE FOR INTERNAL PARTS.

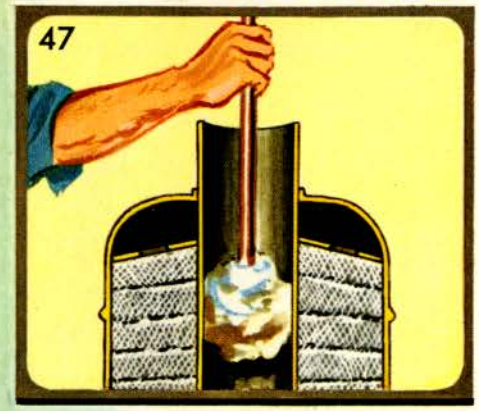
45

A good rule is to change oil when it becomes murky, cloudy or thicker than normal.

46

Wash screens every 60 to 240 hours, depending upon dust conditions.

47

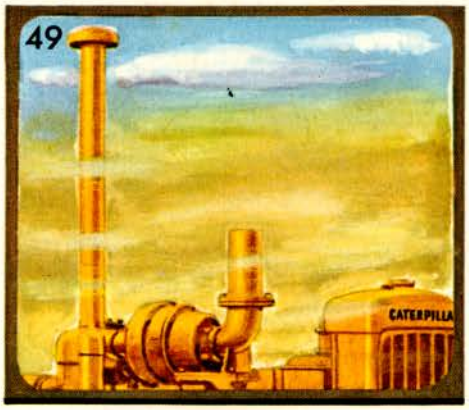


Remove dirt from inside air intake pipe, as dirt restricts the opening and reduces horsepower.

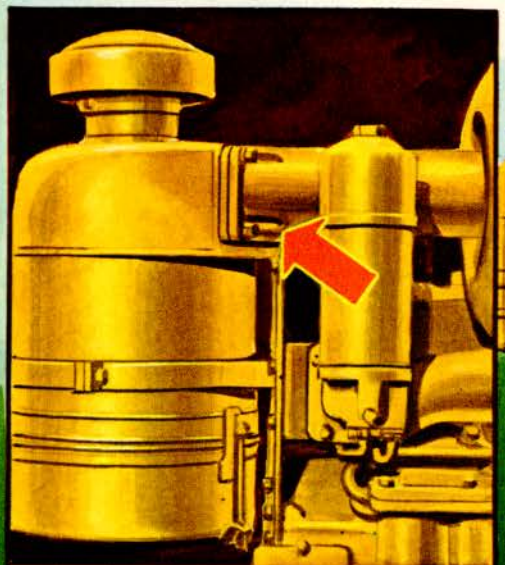
48

When it gets dirty, wash pre-cleaner with soapy water.

49



Under dusty conditions use an extension air intake and place engine upwind from dust source.



Keep *all* connections tight to prevent entry of abrasive dust.

51

ALSO IMPORTANT IS THE HANDLING OF ***EXHAUST.*** WHEN ENGINES ARE OUT DOORS, USE A RAIN TRAP, OR SOME OTHER DEVICE TO KEEP OUT SNOW AND RAIN.

52

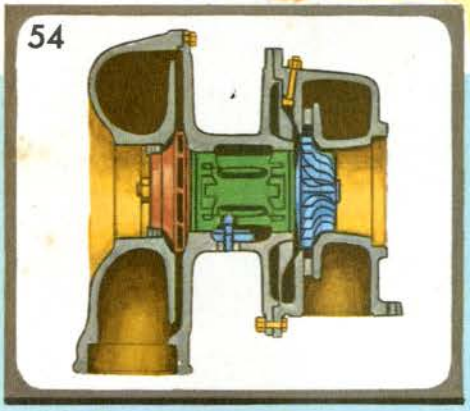
To assure proper intake and exhaust operation, valve clearance should be checked and adjusted if necessary every 500 hours except on the D337 and D326 which have hydraulic adjusters. Your Operation and Maintenance Instructions Booklet gives you the valve settings.

CLEARANCE TOO GREAT

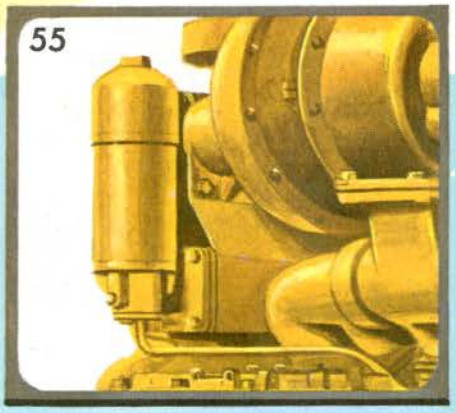
Valve closes with excessive impact resulting in "beat-in" valve seats and badly worn valve faces.

CLEARANCE TOO SMALL

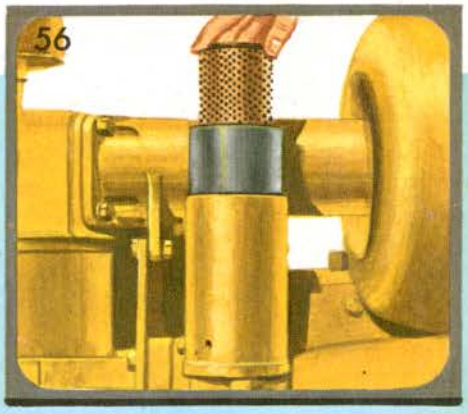
Poor valve seat contact resulting in loss of compression and burned or guttered valve seat surfaces.



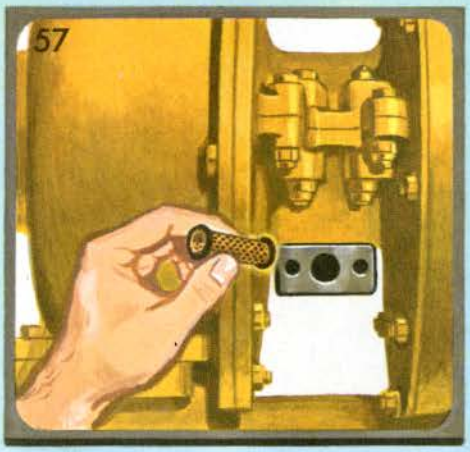
To obtain maximum efficiency from turbocharged engines, the turbocharger should be kept in good operating condition.



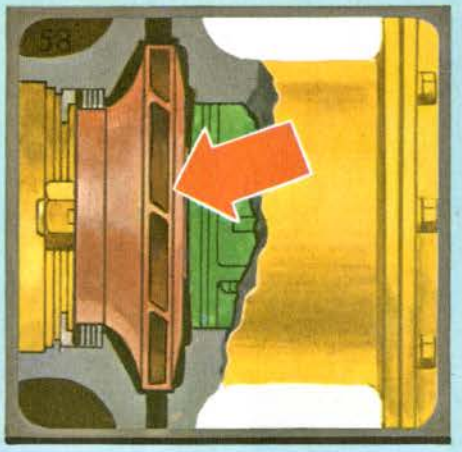
Check tightness of mounting and connections daily to prevent unnecessary vibrations. Check oil supply inlet tube for leakage.



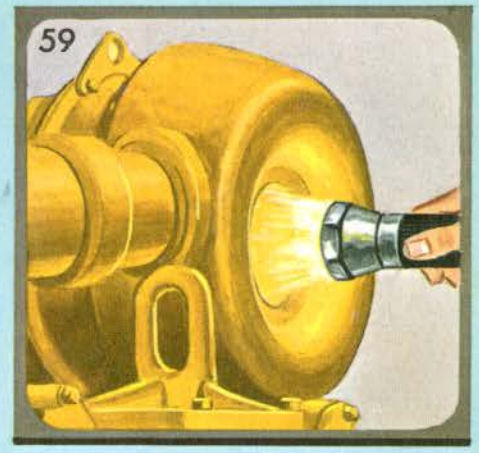
Change turbocharger oil filter periodically as recommended in the Operation and Maintenance Instructions booklet.



After the first 60 hours and every 1000 hours thereafter remove oil strainer and clean. Clean around connection, disconnect oil line from adapter and remove strainer. Wash strainer in clean diesel fuel and replace.



Dirt deposits accumulate on turbocharger impeller, first on back and then entirely around it. If these deposits harden and chip off, impeller could become unbalanced and premature bearing failure could occur.†

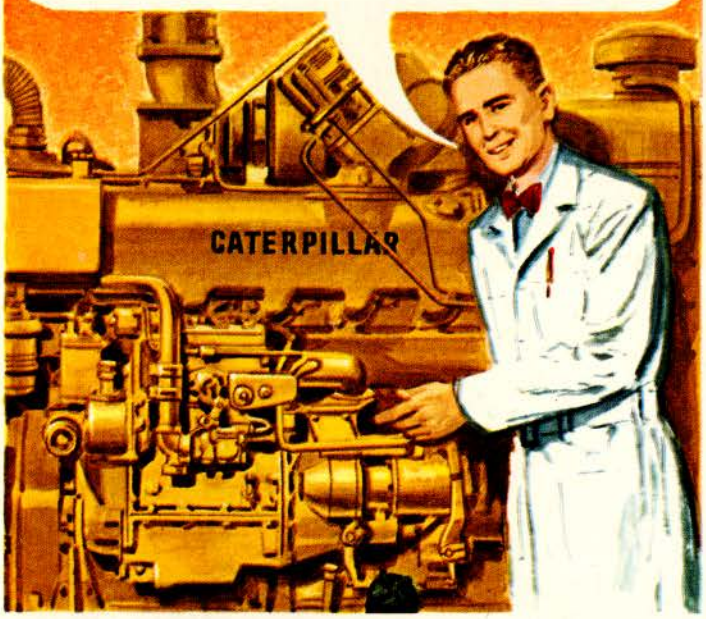


Visually inspect impeller every 500 hours, or oftener under dusty conditions, by removing air inlet and outlet piping from impeller housing. If impeller needs cleaning, see your Caterpillar Dealer.†

†Applicable only to turbochargers on D353, D337.

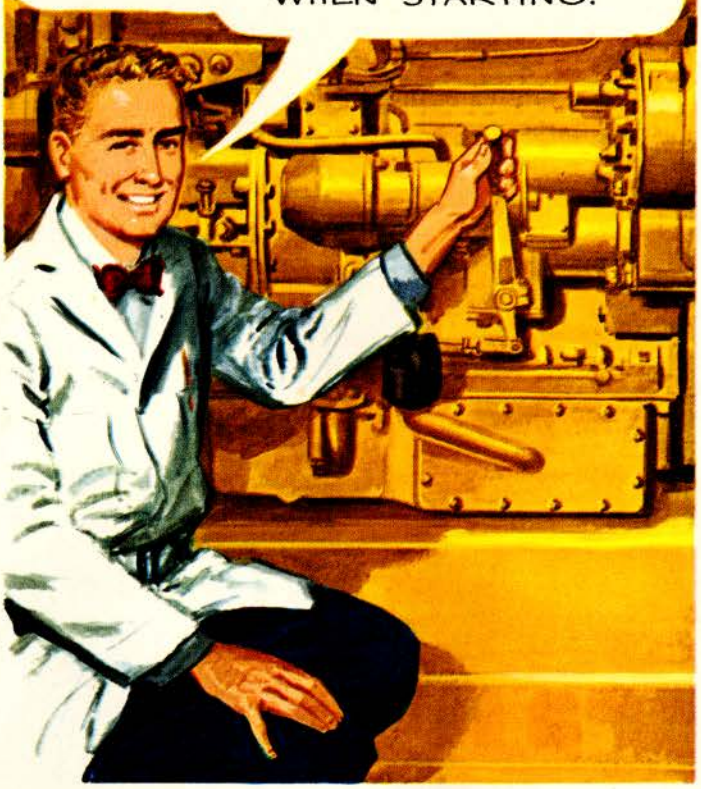
60

THE **STARTING SYSTEM** OF YOUR ENGINE MUST BE PROPERLY USED AND MAINTAINED, TOO. STARTING ENGINES OR MOTORS SPEND ALL THEIR LIVES STARTING AND STOPPING. IF TROUBLE-FREE OPERATION IS EXPECTED THEY MUST BE STARTED AND STOPPED CORRECTLY.



61

TO PREVENT DAMAGE TO THE STARTER PINION OR FLYWHEEL RING GEAR, DO THESE THINGS WHEN STARTING.



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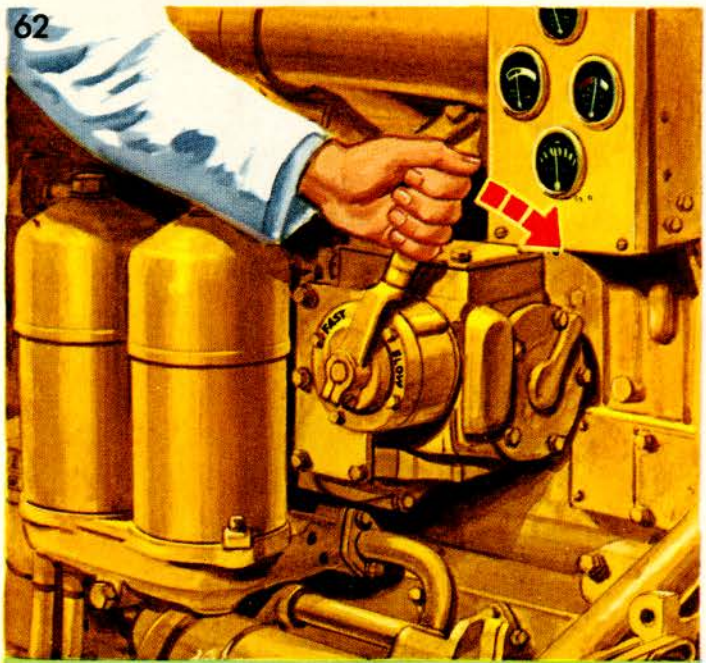
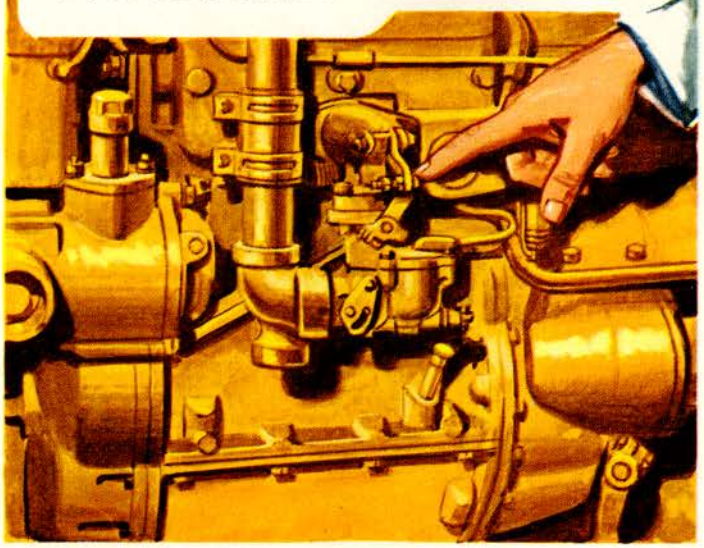


Check crankcase oil level in diesel and in starting engine. See that starting engine and flywheel clutches are disengaged. Move governor control to closed position and set compression release lever to START or OFF position. Loosen starting engine fuel valve.

63

PULL OUT, OR TURN CLOCKWISE, STARTING ENGINE CHOKE KNOB, AND PULL OUT THROTTLE CONTROL. ON SOME ENGINES THE THROTTLE CONTROL IS POSITIONED BY AN IDLING LATCH. TURN IGNITION SWITCH TO *ON.* CRANK STARTING ENGINE AND CLOSE CHOKE AS NECESSARY. SEE OPERATION AND MAINTENANCE INSTRUCTIONS FOR DETAILED PROCEDURE.

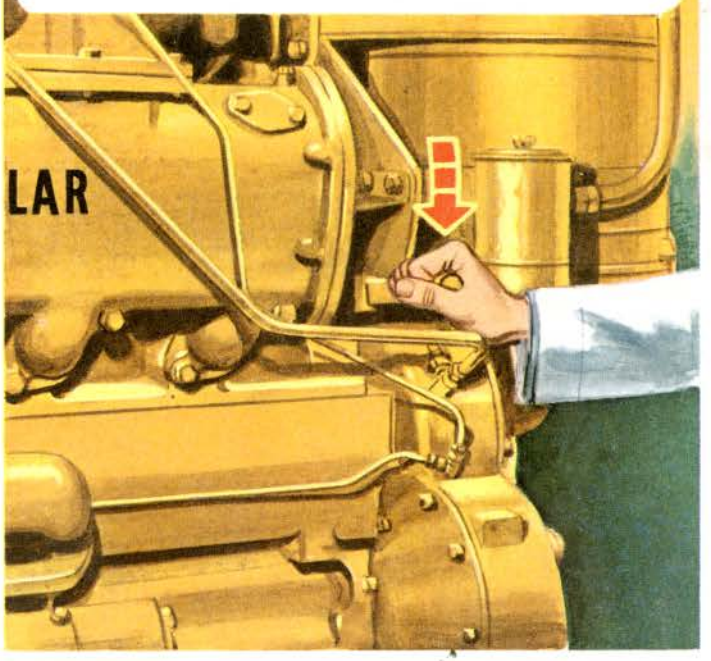


64

When starting engine idles smoothly, put the clutch and starter pinion control lever in "brake applied" position for 5 seconds. Then position lever to engage starter pinion with flywheel ring gear. Set throttle control to let starting engine run at full speed.

65

MOVE COMPRESSION RELEASE LEVER TO *ON.* WHEN THE DIESEL ENGINE IS WARM, OPEN THE DIESEL GOVERNOR CONTROL LEVER TO START THE ENGINE. THE STARTER PINION CONTROL LEVER AUTOMATICALLY DISENGAGES.



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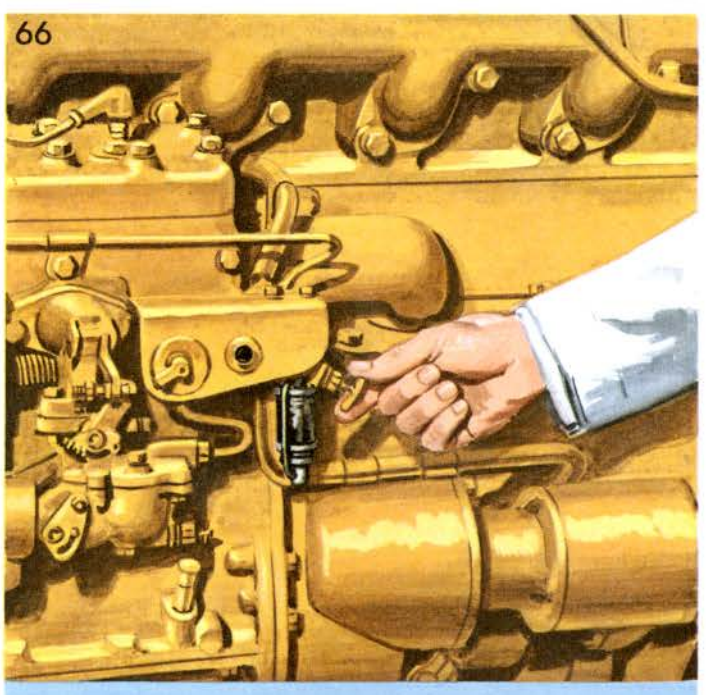
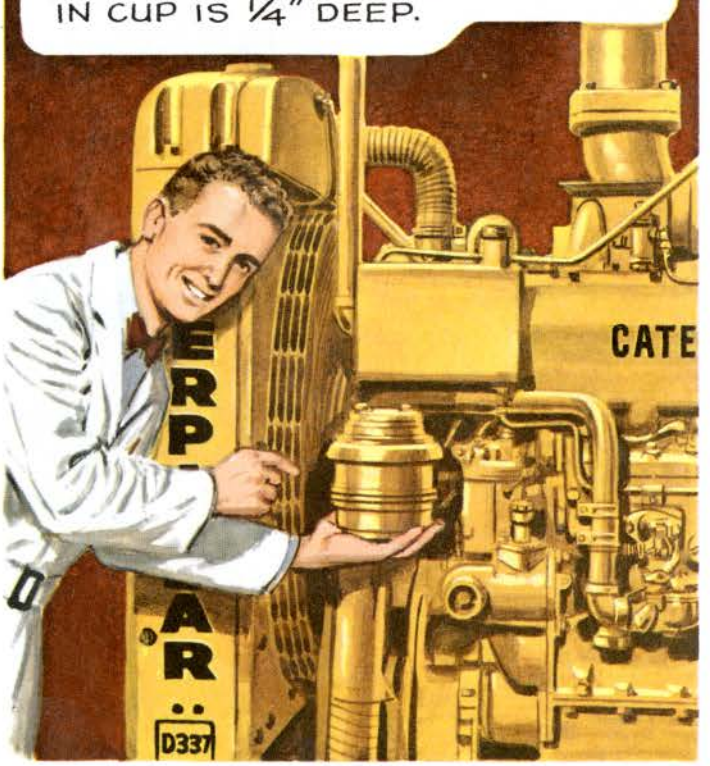


It is important to stop the starting engine by turning off its fuel. This drains the carburetor thus prolonging float valve and bearing life. *Do not turn off the ignition switch* to stop the starting engine.

After the diesel starts it should warm up for *five minutes* at about half speed before applying the load.

67

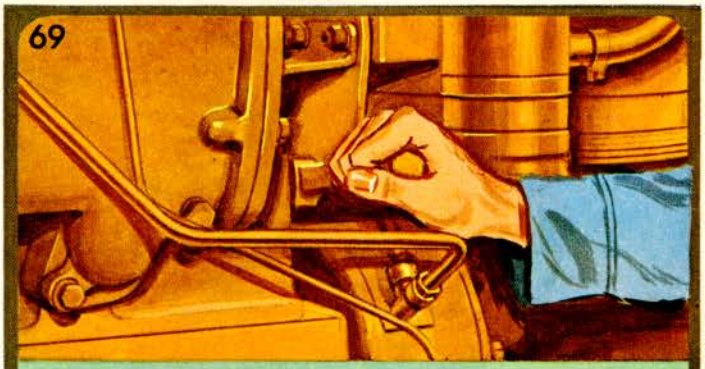
WASH THE STARTING ENGINE AIR CLEANER AND REFILL THE OIL CUP WHEN OIL WILL NOT FLOW FREELY OR IF SEDIMENT IN CUP IS ¼" DEEP.



68

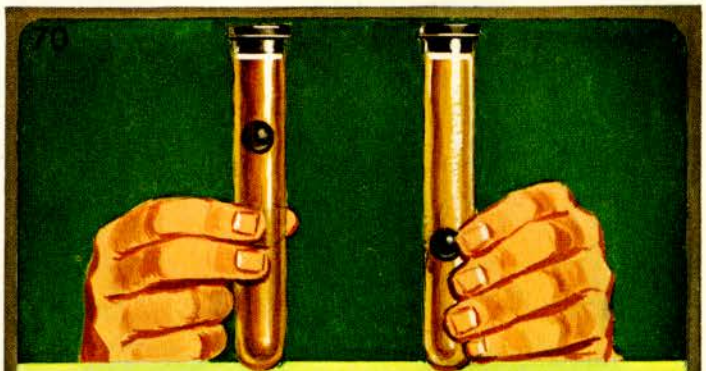
YOUR ENGINES WITH DIRECT ELECTRIC STARTING WILL START EASILY IN TEMPERATURES RANGING AS LOW AS 50°F WITHOUT THE USE OF STARTING AIDS. FOR DEPENDABLE STARTING KEEP THE BATTERIES FULLY CHARGED AND THE BATTERY TERMINALS CLEAN AND TIGHT. THE GENERATOR AND VOLTAGE REGULATOR MUST FUNCTION CORRECTLY.

69



With direct electric starting the compression release lever normally remains in the RUN position. Move governor control to about half engine speed position. (Push oil pressure shut-off reset button if your engine has it.) Press starter button to crank diesel engine against compression.

70



With direct electric starting it is important to use light lubricating oil in the diesel engine crankcase in cold weather. For instance, when the operator needs a warm jacket, the diesel engine needs light oil to start easily and lubricate properly during the first hour's operation.

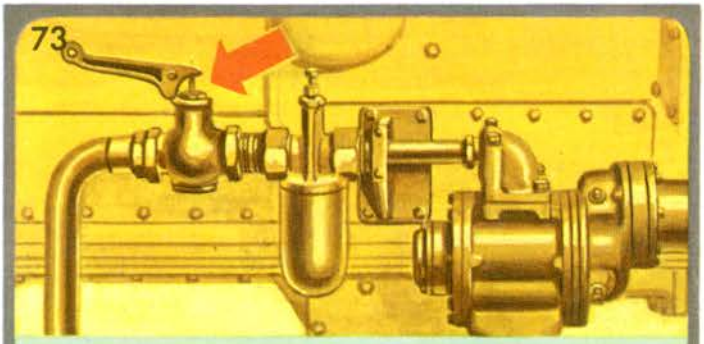
71

IF THE ENGINE FAILS TO START WITHIN 30 SECONDS, RELEASE THE BUTTON AND WAIT TWO MINUTES TO ALLOW THE STARTING MOTOR TO COOL.

72

AIR STARTING CAN BE USED SUCCESSFULLY IN TEMPERATURES OF 32°F OR ABOVE WITHOUT STARTING AIDS. THE COMPRESSION RELEASE LEVER AND THE GOVERNOR CONTROL ARE SET THE SAME AS FOR ELECTRIC STARTING.

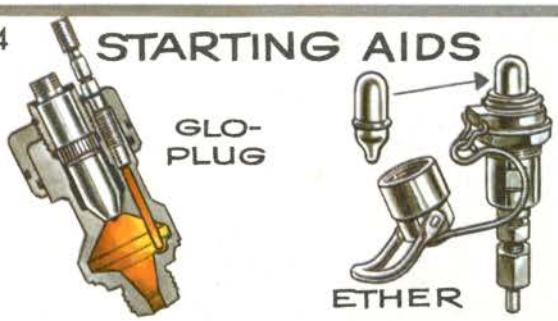
73



Open air valve to crank engine. Compression release should be in RUN position. If engine doesn't start in seconds, continue to crank diesel but shut off fuel for about 10 seconds to clear cylinders of raw fuel. If starting motor pinion disengages before engine starts, release air valve.

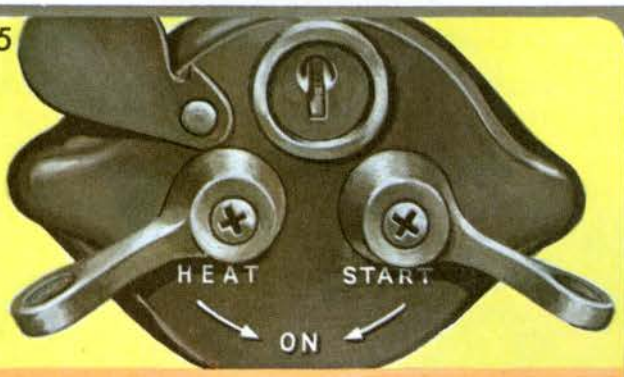
74

STARTING AIDS



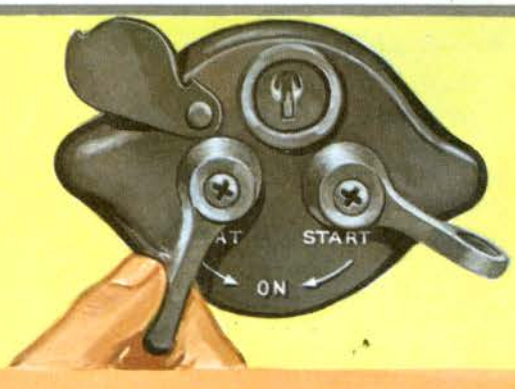
To prevent long cranking and fast battery discharge, glow plugs or ether aids should be used in cool weather down to freezing. Below this, ether should be used as an aid for starting even though the engine may be equipped with glow plugs. This also applies to air starting.

75



To use glow plugs with electric or air starting, controls should be positioned as normal for that particular starting system. Move HEAT switch to ON for a few seconds, then move START switch to ON and crank engine.

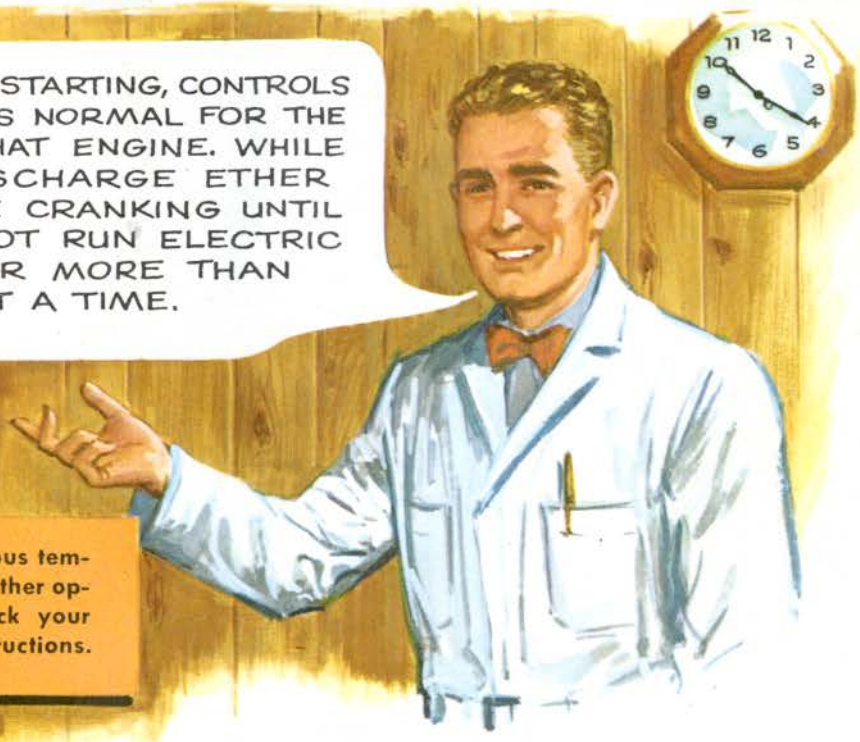
76



If engine fails to start after 10 seconds, cranking should be stopped. Continue to hold the HEAT switch ON for about 30 seconds before cranking engine again. *Do not turn glow plug switch ON while engine is warm and running.*

77

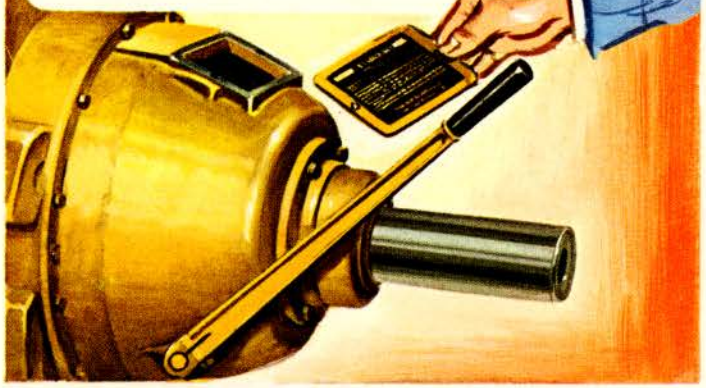
WHEN USING ETHER FOR STARTING, CONTROLS SHOULD BE POSITIONED AS NORMAL FOR THE STARTING SYSTEM ON THAT ENGINE. WHILE CRANKING ENGINE, DISCHARGE ETHER CAPSULE AND CONTINUE CRANKING UNTIL ENGINE STARTS. DO NOT RUN ELECTRIC STARTING MOTOR FOR MORE THAN 30 SECONDS AT A TIME.



For proper lubricating oil at various temperatures and for other cold weather operating and starting hints, check your Operation and Maintenance Instructions.

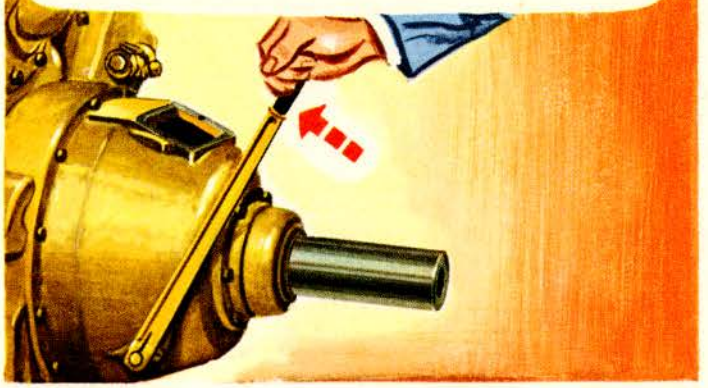
78

KEEP **CLUTCHES** PROPERLY ADJUSTED TO MINIMIZE WEAR. IF CLUTCH IS SLIPPING, REMOVE INSPECTION COVER TO SEE IF OIL IS ON CLUTCH FACINGS. IF THERE IS, — LOOK FOR A LEAKING GASKET OR SEAL.



79

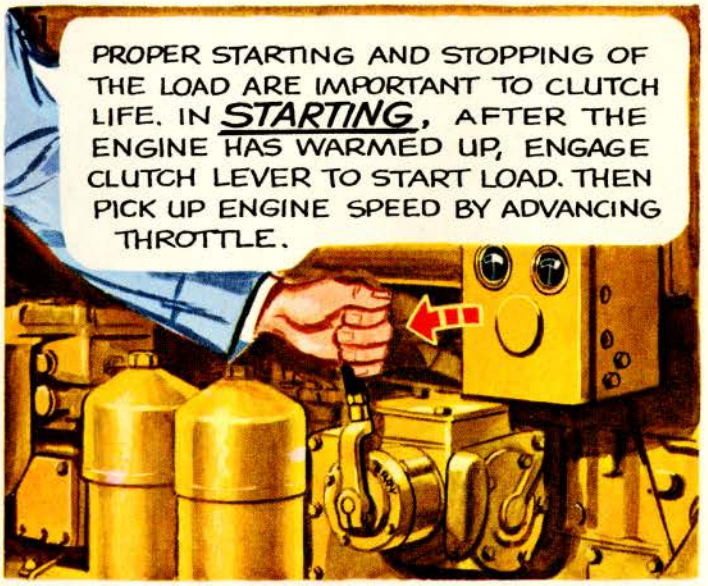
THE CLUTCH LEVER SHOULD GO INTO THE ENGAGED POSITION WITH A DISTINCT SNAP AND SHOULD REQUIRE A REASONABLY HARD PUSH. THE STARTING ENGINE CLUTCH ALSO NEEDS ADJUSTING OCCASIONALLY.



80

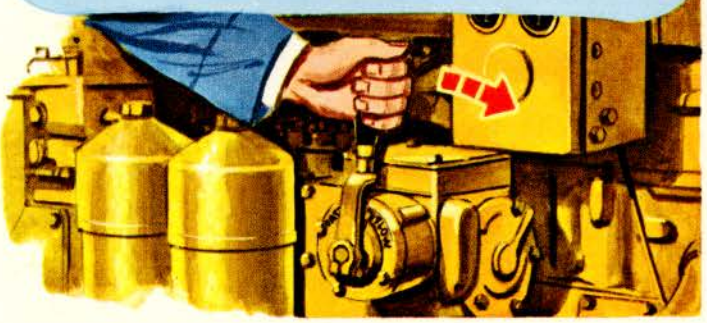
READ YOUR OPERATION AND MAINTENANCE INSTRUCTIONS REGARDING PROPER INTERVALS AND PROCEDURE FOR DRAINING, CLEANING AND REFILLING STARTING ENGINE CLUTCH HOUSING AND DRAINING FLYWHEEL CLUTCH HOUSING.

PROPER STARTING AND STOPPING OF THE LOAD ARE IMPORTANT TO CLUTCH LIFE. IN ***STARTING***, AFTER THE ENGINE HAS WARMED UP, ENGAGE CLUTCH LEVER TO START LOAD. THEN PICK UP ENGINE SPEED BY ADVANCING THROTTLE.



82

IN ***STOPPING***, DISENGAGE CLUTCH AND MOVE GOVERNOR CONTROL LEVER TO REDUCE SPEED. FOR ***STOPPING THE DIESEL***, AFTER LOAD IS REMOVED, IDLE ENGINE FOR FIVE MINUTES AT HALF SPEED. TO STOP IT MOVE GOVERNOR CONTROL LEVER TO CLOSED POSITION.



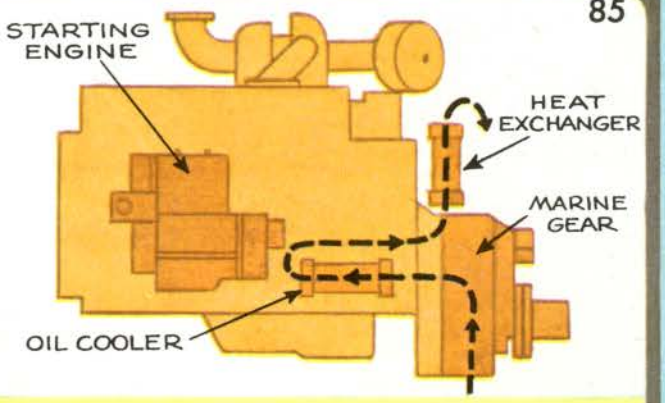
83

IS THE MAINTENANCE OF A **MARINE ENGINE** THE SAME AS THE OTHERS?

84

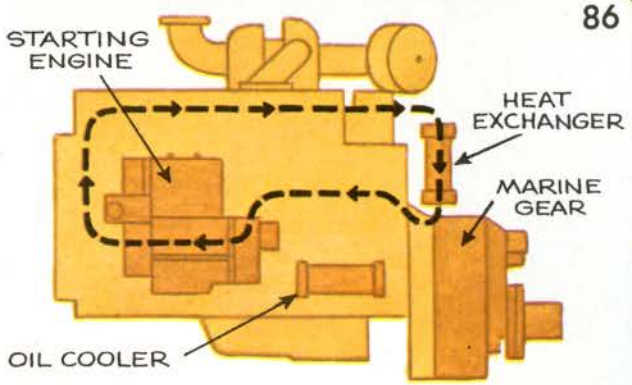
MAINTENANCE ON THE **MARINE ENGINE** IN YOUR TOWBOAT IS THE SAME AS FOR OTHER ENGINES, EXCEPT FOR THE MARINE ATTACHMENTS. THE ENGINE IS EQUIPPED WITH A HEAT EXCHANGER, AND YOU HAVE TWO SEPARATE WATER SYSTEMS.

85



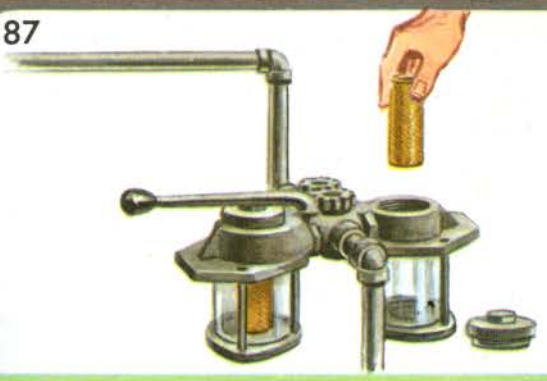
Raw water is taken from the river or sea and is pumped through marine gear, engine oil cooler and jacket water heat exchanger before being discharged overboard.

86



Fresh water, or jacket water, cools the diesel and starting engine, and the diesel engine exhaust manifold.

87

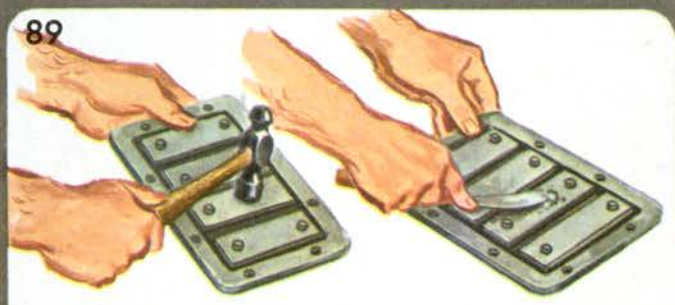


To keep debris, trash and sand out of raw water system, a strainer is used. Water strainers, either single or duplex units, are easy to clean. The duplex type can be cleaned with boat underway.

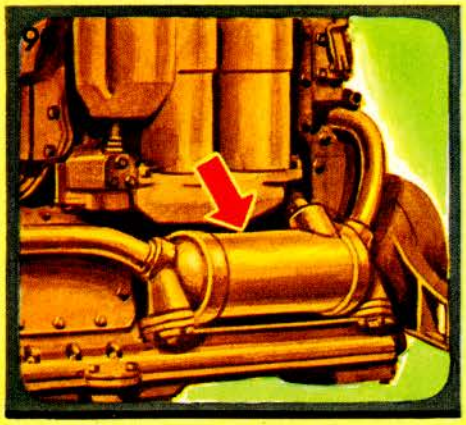
88

Use soft or treated water for engine cooling to prevent formation of hard scale and rust. Clean heat exchanger when water temperature remains at 205° F or more during operation. Marine growths or sediment should be removed or loosened by a brush on the end of a rod. These will be flushed out when engine is operated.

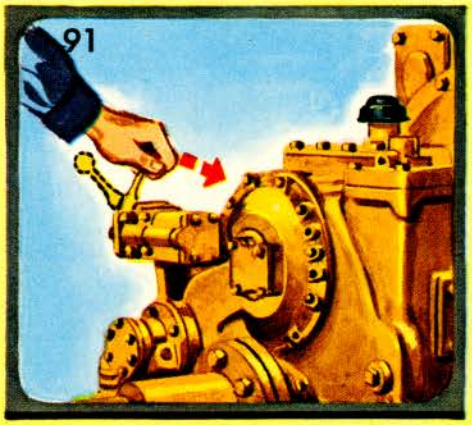
89



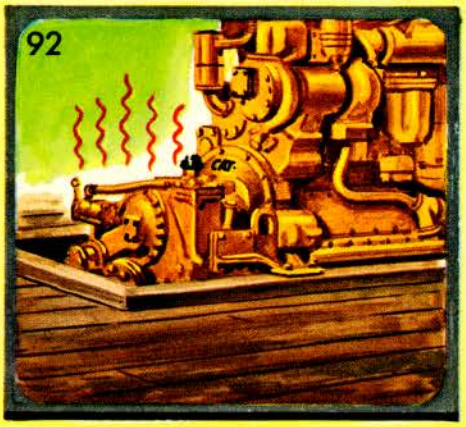
Zinc plugs and plates are installed in the raw water system to localize electrolytic action. Gradually, the zinc decomposes. Inspect these plates and plugs once a month, tapping plates with small hammer to see that they are solid. Corroded plates may be scraped clean, but porous ones should be replaced.



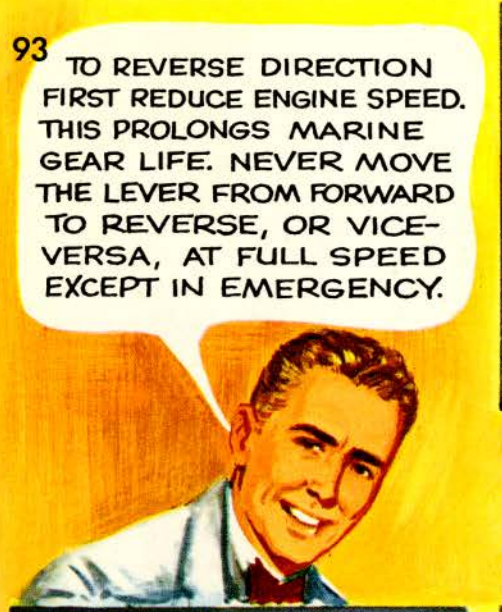
Engine lubricating oil is cooled by raw water circulating through an oil cooler. When you service the heat exchanger, also clean the oil cooler. Brush outside surfaces of core, and remove foreign matter from inside core and cover. Check condition of zinc plug.

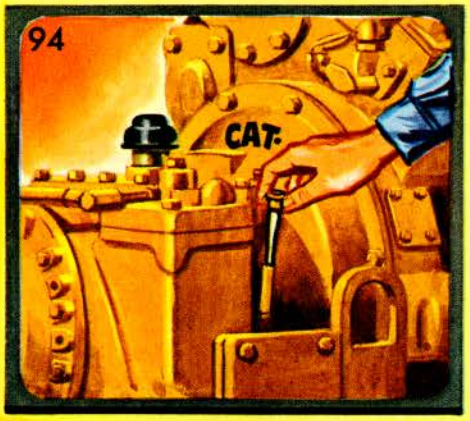


A few simple maintenance points will prolong life of the marine gear. Always make sure the clutch is fully engaged, or slippage and rapid clutch wear will result. Be certain remote controls move lever through full travel for complete clutch engagement.

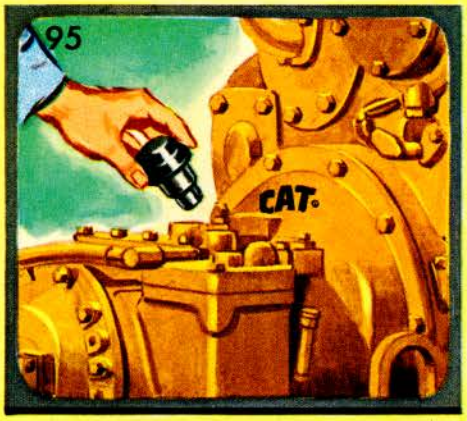


One sign of slippage is excessive heat. Check marine gears regularly for clutch slippage in both forward and reverse rotation. See Marine Gear Operation and Maintenance Instructions for positive checking procedure with tachometer.

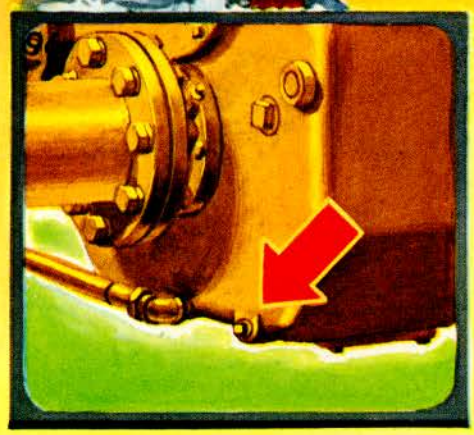

TO REVERSE DIRECTION FIRST REDUCE ENGINE SPEED. THIS PROLONGS MARINE GEAR LIFE. NEVER MOVE THE LEVER FROM FORWARD TO REVERSE, OR VICE-VERSA, AT FULL SPEED EXCEPT IN EMERGENCY.



Check marine gear oil level with engine stopped every 10 hours. At same interval turn oil filter handle a few turns to clean collected particles from filter screens.



Every 250 hours remove gear case breather (if your gear is so equipped), disassemble and wash in clean diesel fuel. Saturate element with oil and reinstall.

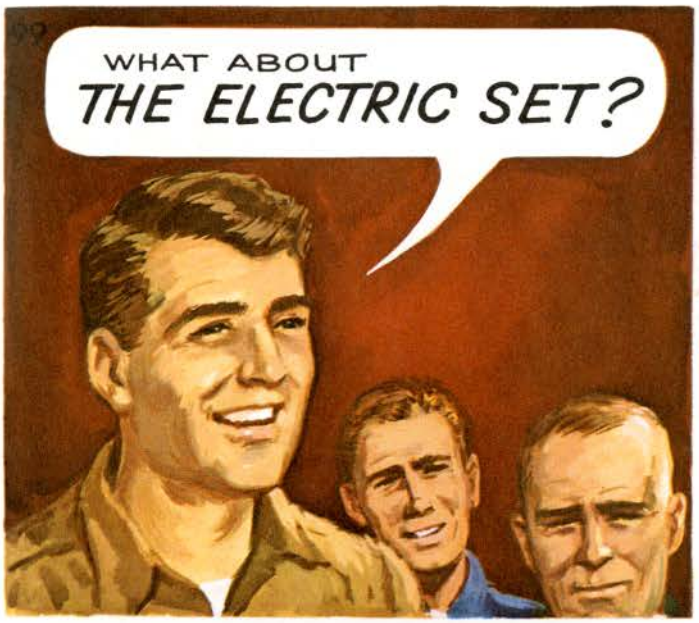


Drain oil from the gear while it is hot and refill with specified lubricant. Change filter element at proper intervals as indicated in Operation and Maintenance Instructions.

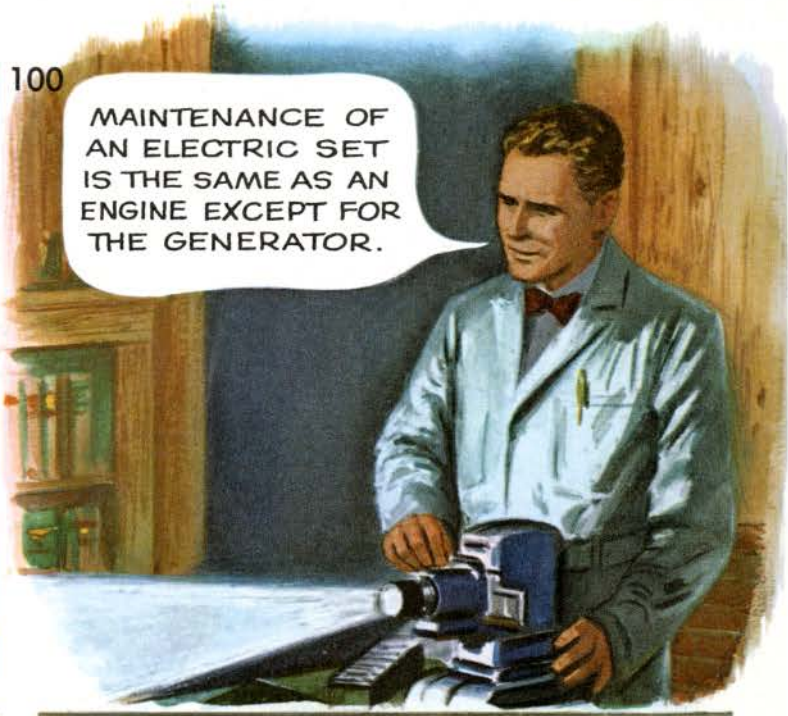
Alignment of coupling should be checked periodically—with vessel in the water. Leakage around stuffing box or output shaft seal in reverse gear may indicate misalignment.

Misalignment causes damage to reverse gear parts and propeller shaft bearing. Holddown bolts should be tight fit in support bracket bolt holes to prevent movement.

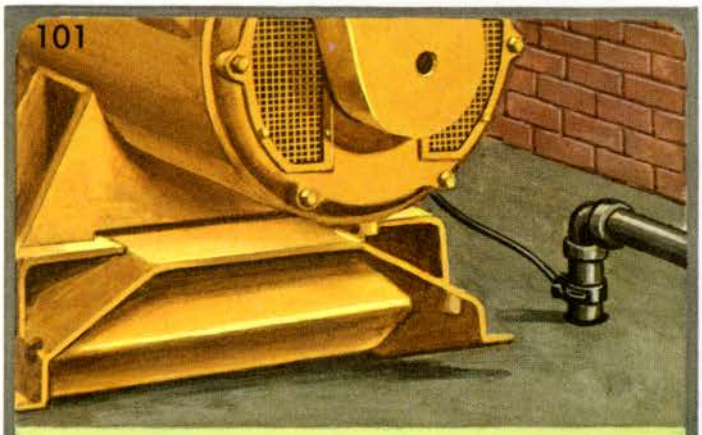
99



100



101



For safety, ground the generator. See your Operation Maintenance Instructions about selection of circuit breaker and generator connections.

102

Periodically clean collector rings with a lint-free cloth. If rings are rough or pitted, they can be turned with a special tool by your Dealer.

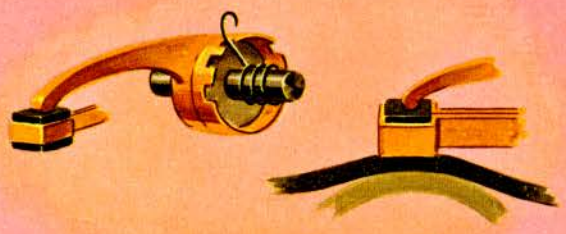
103

When windings, ventilating ducts and internal parts become dust-covered, they may be cleaned with a vacuum cleaner. Use some type of non-metal tip on hose to prevent damage to parts. Grease or oil should be removed with the proper cleaner. See Instruction Booklet.

104

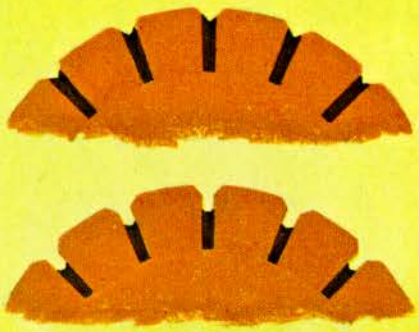
Operating temperature of generator normally is high enough to be uncomfortable when touched. To prevent generator overheating the temperature within the engine room should not exceed approximately 110°F. If temperature is higher, room temperature must be reduced or load reduced.

105



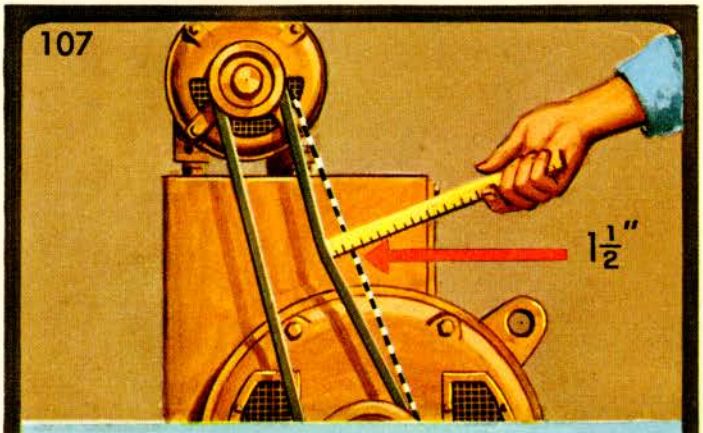
Brushes should have continuous contact with commutator, and spring tension should be adjusted as brushes wear. When fitting new brushes use "0000" sandpaper with grit toward brush to shape it to commutator. Brushes should be free in their holders.

106



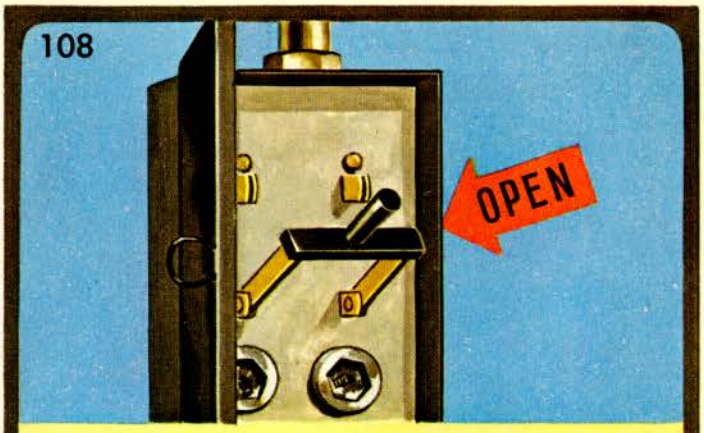
Commutator segments should have a high polish, and the mica insulation should be properly undercut. Clean commutator with lint-free cloth.

107



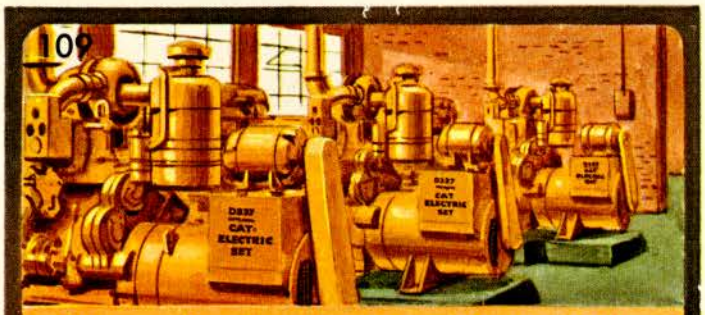
Adjustment of belts from exciter to generator should be checked often. With two belts slack should be 1½", and it should be ½" for a single belt.

108



When starting the diesel, be sure switch is open to eliminate excess load on engine's starting mechanism.

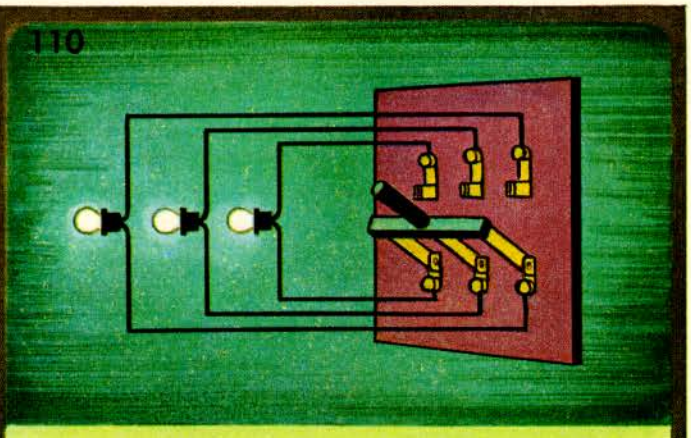
109



When synchronizing two or more electric sets for parallel operation care must be taken. They must have:

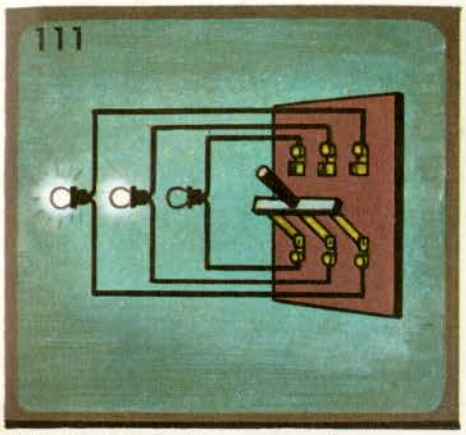
1. Same rated voltages
2. Same voltage droop from no load to full load
3. Same rated frequencies
4. Same speed droop from no load to full load. (One machine only may be operated on isochronous governor control to maintain frequency.)
5. Same phase rotation

110



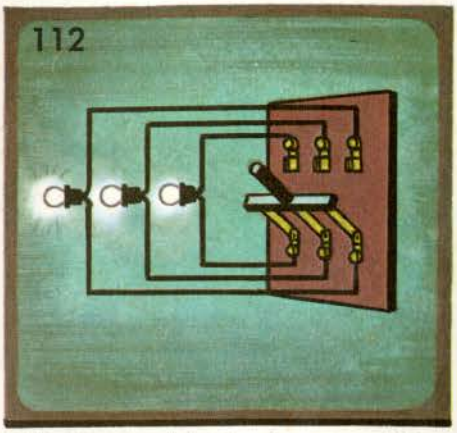
Two or three synchronizing lights installed across circuit breaker or knife switch are required to check phase rotation. If lights blink in unison, phase rotation is same on both machines.

111



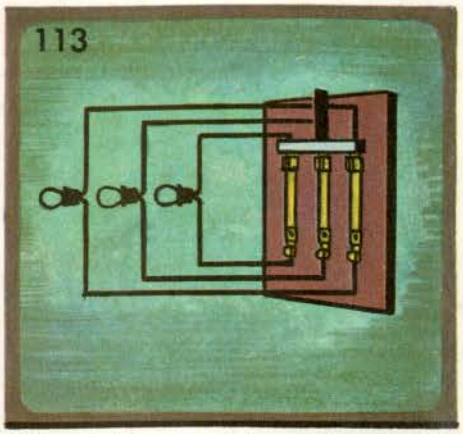
If lights blink alternately, phase rotation is different. Switching any two phase leads of one generator will make phase rotation the same on both generators. Phase position is indicated by brilliance of lights.

112



If lights are bright, phase positions are different. If lights are out, phase position is same. The governor control of one engine should be adjusted so lights blink less than 10 times a minute.

113



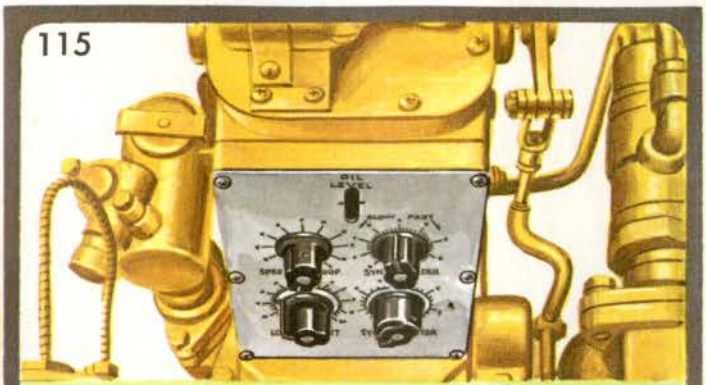
When lights are out, the switch should be closed quickly to put the second generator in parallel. If generators are paralleled at no load, then the load can be applied after paralleling is completed.

114

WHERE IT IS DESIRED TO MAINTAIN VERY CLOSE FREQUENCY ON PARALLELED UNITS, AN ISOCHRONOUS GOVERNOR CAN BE USED ON ONE UNIT. (THE LOAD CHANGE MUST NOT BE GREATER THAN 50% OF THE RATED CAPACITY OF THE ISOCHRONOUS UNIT.)

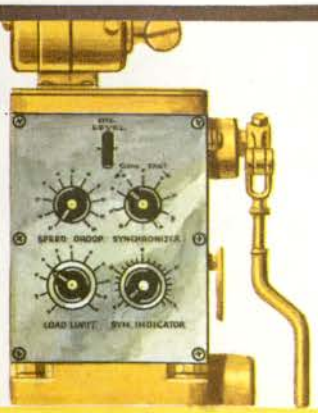
If one generator has been carrying the load and the second is paralleled with it, the governor control of the second unit should be advanced so the second generator will pick up its share before additional load is applied.

115



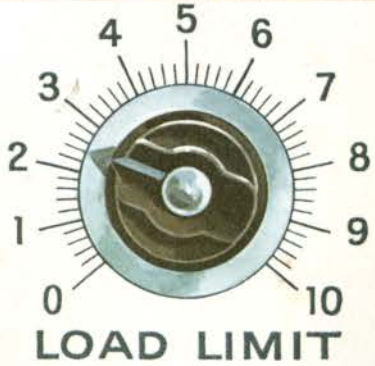
The electric set equipped with a Woodward isochronous governor can be set to operate with no speed droop. That governor will then control the frequency of the system. All other engine governor controls must have at least 3% speed droop.

116

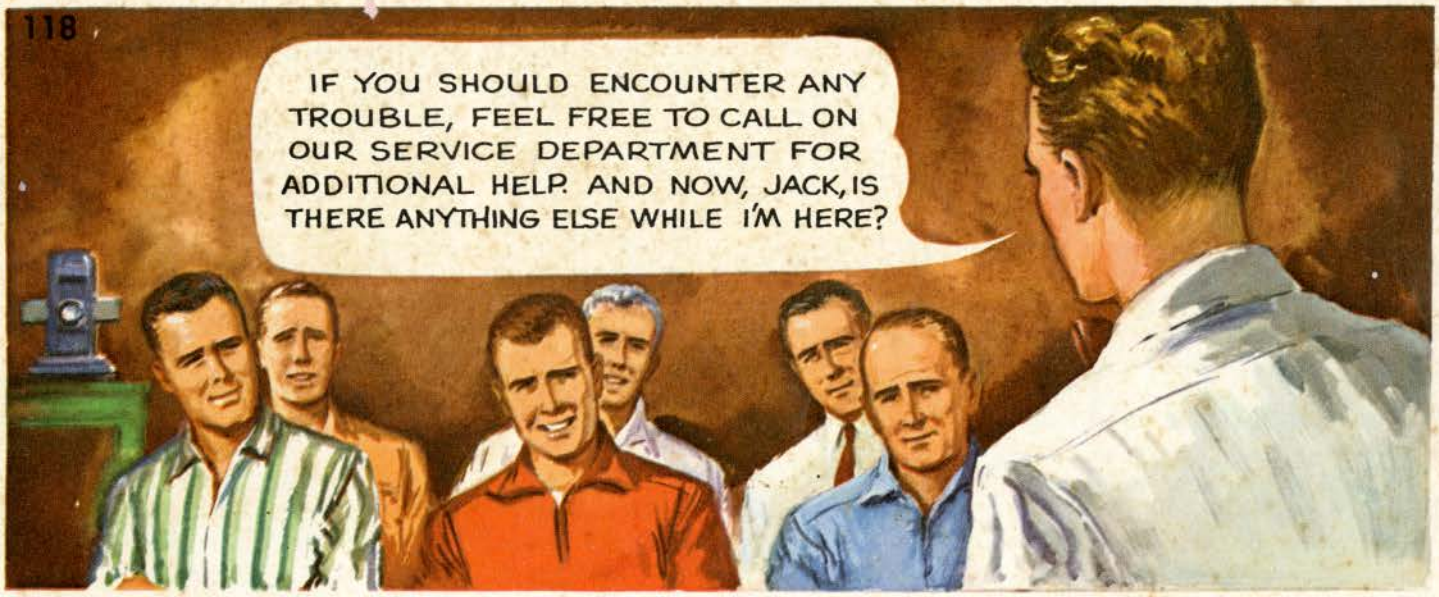


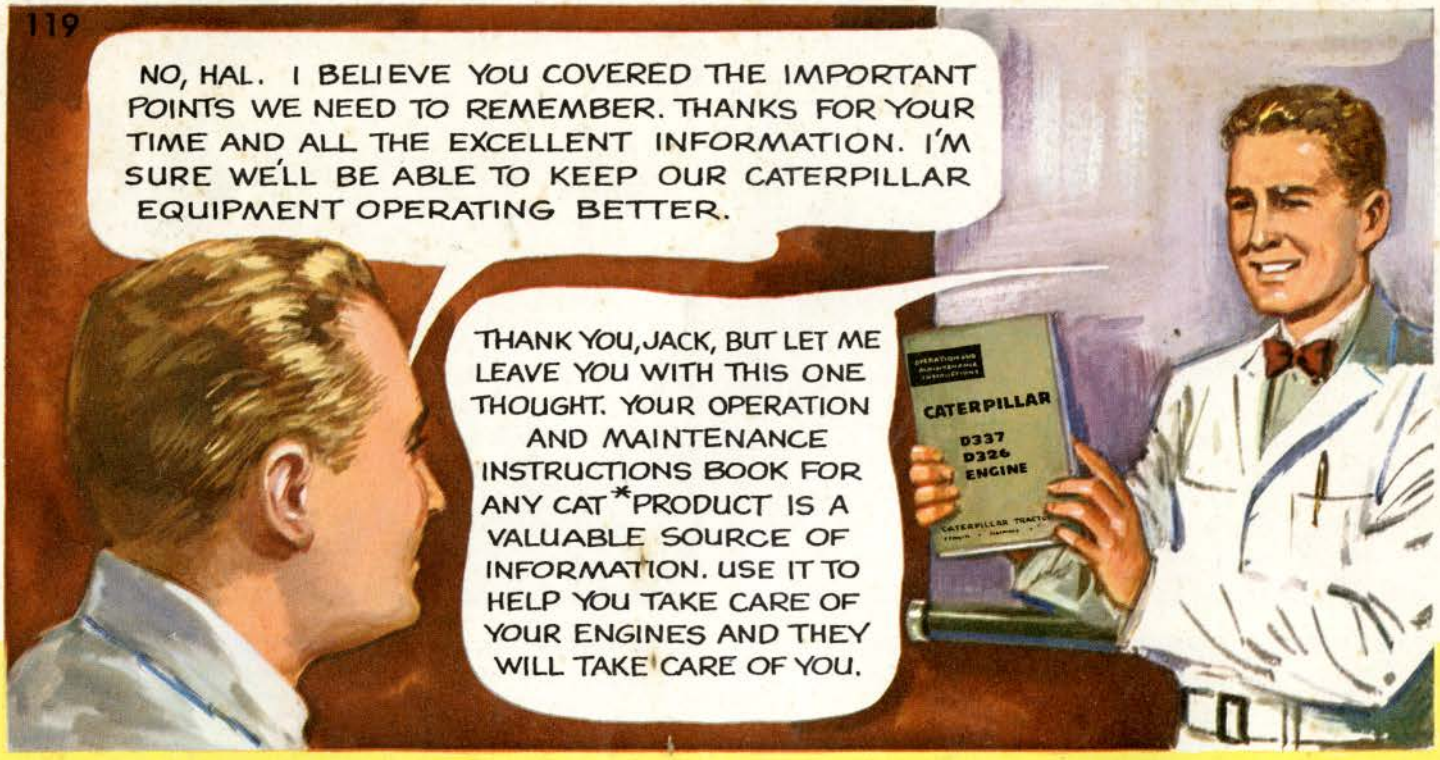
The Woodward Governor has four controls on the panel. The upper left knob shows speed droop on the dial. The upper right or synchronizer knob is turned to increase or decrease engine speed. The dial on lower right indicates number of revolutions synchronizer control has been turned.

117



The load limit control on the lower left limits the engine fuel rack setting from shut-off at 0 to full load at 10. A load indicator pointer on the load limit scale shows proportion of load as indicated by rack position.


118
IF YOU SHOULD ENCOUNTER ANY TROUBLE, FEEL FREE TO CALL ON OUR SERVICE DEPARTMENT FOR ADDITIONAL HELP. AND NOW, JACK, IS THERE ANYTHING ELSE WHILE I'M HERE?


119
NO, HAL. I BELIEVE YOU COVERED THE IMPORTANT POINTS WE NEED TO REMEMBER. THANKS FOR YOUR TIME AND ALL THE EXCELLENT INFORMATION. I'M SURE WE'LL BE ABLE TO KEEP OUR CATERPILLAR EQUIPMENT OPERATING BETTER.
THANK YOU, JACK, BUT LET ME LEAVE YOU WITH THIS ONE THOUGHT. YOUR OPERATION AND MAINTENANCE INSTRUCTIONS BOOK FOR ANY CAT *PRODUCT IS A VALUABLE SOURCE OF INFORMATION. USE IT TO HELP YOU TAKE CARE OF YOUR ENGINES AND THEY WILL TAKE CARE OF YOU.
CATERPILLAR
D337
D326
ENGINE

CATERPILLAR*

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WM. H. ZIEGLER CO., INC.

2929 UNIVERSITY AVENUE, S. E.
Minneapolis, Minnesota

1115 S. MAIN STREET
Crookston, Minnesota
37TH ST. & 6TH AVE., W.
Hibbing, Minnesota

330 GARFIELD AVENUE
Duluth, Minnesota
BOX L
Mankato, Minnesota

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